Comparative Analysis of Behavioral Reactions and Morphological Changes in the Rat Brain After Exposure to Ionizing Radiation with Different Physical Characteristics

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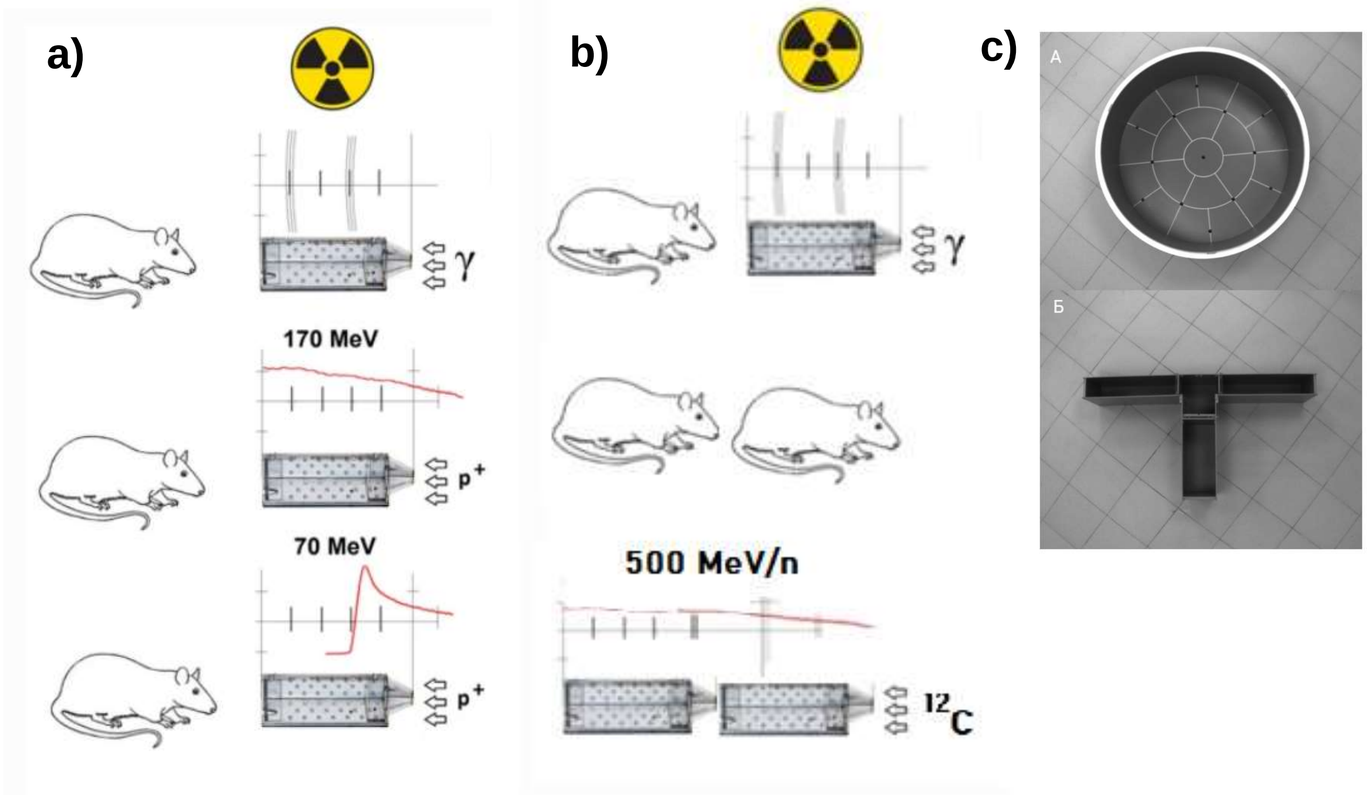
Human brain can be exposed to protons and heavy ions as a result of medical exposure, as well as during a manned space mission. Despite a large number of studies in this area, the problem of evaluation of behavioral reactions and morphological changes in the central nervous system after exposure of radiation. In this field of neurobiology, there is still the lack of knowledge, yet an obvious connection between structural and functional disorders.

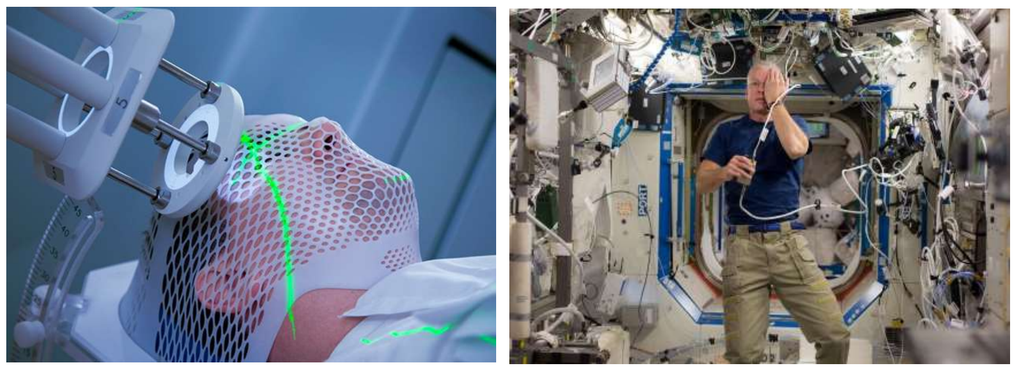
Research aim. Comparative analysis of behavioral reactions and morphological changes in the brain of adult rats after exposure to gamma radiation, protons of various energies and carbon ions at a dose of 1 Gy.



Irradiation and Behavioral Procedures. a) Gamma and Proton irradiation; b) Gamma and Carbon Ions Irradiation; c) Behavioral tests (Open Field and T maze).

Results. Irradiation with protons with an energy of 70 MeV on the rat brain leads to a decrease in the motor activity of rats (Open Field Test), an increase in the relative number of dystrophic changes in the cortex, cerebellum, and hippocampus, the development of amyloidosis in the forebrain, and chromatolysis of the ependymocytes layer on day 30 after irradiation. Exposure to ionizing radiation with different physical characteristics in the same dose leads to a decrease in working memory (T maze) and exploratory behavior in rats. Behavioral disorders, dystrophic and morpho-functional changes in the hippocampus, cortex and cerebellum depend on the linear energy transfer and the physical characteristics of the charged particle beam used. On day 30 after irradiation with carbon ions, an increase in the number of neurons with dystrophic changes is observed. In the long term (90 days) after irradiation, elimination of dystrophic cells in the cerebellum of rats is observed.

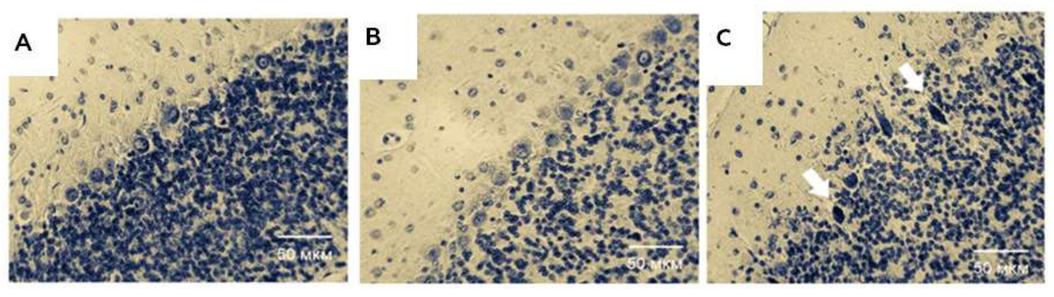
References. Severyukhin, Y.S., Lalkovičová, M., Utina, D.M. *et al.* Comparative Analysis of Behavioral Reactions and Morphological Changes in the Rat Brain After Exposure to Ionizing Radiation with Different Physical Characteristics. *Cell Mol Neurobiol* (2022). https://doi.org/10.1007/s10571-021-01187-z



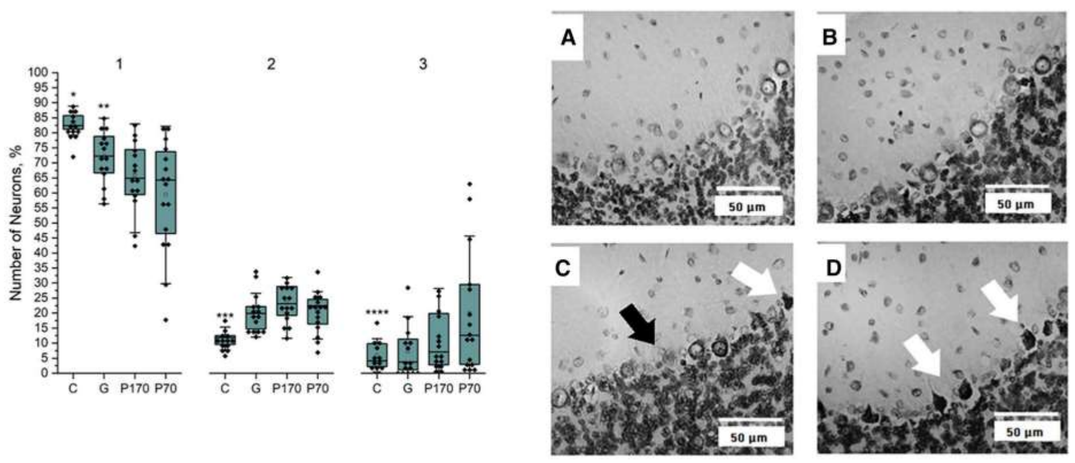
a) Group	Dose, Gy	Dose Rate, Gy/min	Flux, particles/cm^2	LET, keV/μm	Number of animals
Control	-	-	-	-	7
Gamma	1	0,8	-	0,2	8
Protones170	1	0,7	1,16 *10^9	0,5	8
Protones70	1	1,2	1,04*10^9	0,97	8

b) Group	Dose, Gy	Dose Rate, Gy/min	Flux, particles/cm^2	LET, keV/μm	Number of animals
Control	-	-	-	-	8
Gamma	1	0,8	-	0,2	9
Ions ^{12}C	1	0,03	6,1 *10^7	10,6	10

Irradiation Conditions. a) Experiment was carried out at the Phasotron of the Medical and Technical Complex (MTC) JINR and ROKUS M; b) Nuclotron JINR and ROKUS M.



Changes of Purkinje cells after heavy ions ^{12}C irradiation. A – control, B – gamma, C - ions ^{12}C.



Changes of Purkinje cells after protones irradiation. A – control, B – gamma, C – protones 170 Mev, D- protones 70 MeV. White arrows - dystrophic cells.